

## ***Guidelines for the Seal Design Application***

This list of information is provided to assist design engineers who are submitting a seal design to MSHA for approval under the requirements of Section 75.335(b) (1) of the Final Rule, which will become effective October 20, 2008. Depending on the type of seal (wall, plug, etc.), and construction details, some of the listed information might not be necessary. The Final Rule can be viewed on the single source page on MSHA's website ([www.msha.gov](http://www.msha.gov)).

NOTE: All examples (*e.g.*) in italics under the categories listed are just random examples and are in no way a requirement or direct recommendation for seal designers.

### **Address Gas Sampling Pipes**

- Specify type of pipe(s), valves, and fittings used in design.
  - *e.g., non-metallic, corrosion-resistant PVC pipe and fittings with metal valves*
- Specify the number, location(s), and means of support for sampling pipe(s).
  - *e.g., one pipe 12 inches from the roof extending to center of 1st inby crosscut supported along its length with standing cribs.*
- Specify the diameter and internal pressure rating of pipe(s), valves and fittings.
  - *e.g., 3/8" inside diameter pipe with an internal pressure rating of 240 psi, which is easily identifiable.*
- Requirements for connecting/installing sampling pipe(s) when existing seals are used.
  - *Specify details*

### **Water Drainage Systems**

- Specify type of pipe(s), valves, and fittings used in design.
  - *e.g., non-metallic, corrosion-resistant PVC pipe and fittings with metal valves\**
- Specify the number and location(s) of pipe(s) and U-trap(s) used.
  - *e.g., two pipes located at the base of the seal, 36" (+/- 2") apart from each other and no closer than 36" from the ribs.*
  - *Depending on the height of the pipe, the u-trap may or may not be recessed into the mine floor.*

- Specify the maximum depth of water that may accumulate against the seal and identify the safety precautions taken to prevent adverse effects on the ribs or floor.
  - *e.g. water depth to the height of the water trap and the ribs shall be bolted and coated with gunnite.*
- Specify the diameter and internal pressure rating of pipe(s), valves and fittings.
  - *e.g., 6" inside diameter pipe with an internal pressure rating of 240 psi, which is easily identifiable.*
- Describe the method to prevent an air exchange through the drainage system.
  - *e.g., u-trap will be maintained full of mineral oil at all times.*
- Describe measures taken to prevent the pipe inlet(s) from becoming clogged by debris.
  - *e.g., a concrete catchment weir, no more than 12 inches high, would be placed across the entry inby the seal to trap sediment and debris.*
- Requirements for connecting/installing sampling pipe when existing seals are used.
  - *Specify details*

## **Methods to Reduce Air Leakage**

- Describe methods and procedures to control/eliminate air leakage after seal installation.
  - *Specify details along with what product would be used to aid in the control/elimination of air leakage*

## **Pressure-Time Curve**

- Specify which pressure-time curve from the Final Rule is being used in the design. Seal designs must be able to resist the same, pressure-time application from both sides of the seal. For a static-equivalent analysis, specify the dynamic load factor (DLF) for the selected pressure-time curve.
  - *e.g., A static-equivalent analysis was performed on both the active and gob side of the seal using the 120-psi, pressure-time curve with a dynamic load factor of 2.*

## **Fire Resistance Characteristics**

- Specify method(s) used to determine fire resistance of seal.
  - *e.g., Both sides of seal would be coated with a MSHA approved sealant, which acts as a flame retardant coating.*

## **Flame Spread Index**

- Specify the surface flammability of the seal (i.e., flame spread index).
  - *e.g., The surface of the seal after application of an MSHA approved sealant has a flame spread index of 25 or less based on ASTM E162.*

## **Entry Size**

- Specify the maximum and minimum entry size that is applicable for the seal design.
  - *e.g., The seal design can be used in entry heights from 3' to 6' and entry widths from 16' to 20'.*
- Specify the required seal thicknesses for the various entry dimensions.
  - *e.g., Provide a table of width/height/thickness corresponding values.*
- Specify the maximum allowable convergence a seal could withstand before the structural integrity would be compromised and the means by which this convergence would be measured on site.
  - *e.g., The maximum allowable convergence on the seal is 1", which would be measured in the center, outby location with a "pogo stick". Permanent reference points will be established using roof bolts installed in the roof and floor near the center of the seal and 12 inches from the face of the seal.*

## **Engineering Design and Analysis**

- Specify the seal design category. (The categories include 50-psi Mainline, 50-psi Longwall Gob-Isolation, 120-psi Mainline, and 120-psi Longwall Gob-Isolation).
  - *e.g., This seal is designed for a 120-psi Mainline use.*
- Specify the type of seal design. (Specific types include wall, plug, combination plug/wall, etc.)
  - *e.g., The seal design submitted is analyzed, and traditionally referred to, as a "plug" design.*

- Provide a complete set of engineering calculations on which the design is based, such as structural analyses (based either on dynamic design or static-equivalent design), drawings, and/or computer modeling results, which explain and justify the design and design strengths.
  - *NOTE: This section would incorporate some information provided from the other sections listed. For example, the specific pressure-time curve selected from the Final Rule (which was addressed under the “Pressure-Time Curve” section) would be the crux of the loading criteria used for the “Engineering Design and Analysis” section. Please make the “Engineering Design and Analysis” section of the application as complete and thorough as possible, which might require a reiteration of information from other sections.*

## **Elasticity of Design**

- Specify the elastic nature of the design and its ability to withstand repeat overpressure applications (A repeat application of the same, selected, pressure-time curve should be analyzed under the “Engineering Design and Analysis” section and the results of that analysis could be used to support the elastic nature of the design.)
  - *e.g., A repeat pressure-time curve loading analysis was performed in the “Engineering Design and Analysis” section. The results of this analysis demonstrate that the seal design is fully elastic, which allows the seal to withstand repeat overpressure applications.*

## **Material Properties**

- Provide the engineering properties used in the design for the seal’s material(s) and provide the testing and/or other supporting documentation for the engineering properties. Information, which should be included, but not limited to, are:
  - Compressive strength(s), shear strength(s), and flexural strength(s) of material(s) used.
  - Specify and explain the time required for the seal to reach its design strength in mine conditions.
  - All other technical data and/or engineering properties for the seal’s material(s) on which the design is based.
    - *e.g., Young’s Modulus, Shear Modulus, temperature-related effects on strength parameters, density, isotropic or anisotropic behavior, curing temperatures, etc.*

## Construction Specifications

*NOTE: This section encompasses a significant amount of information. All the information below might not pertain to a particular seal design. Also, there might be construction specifications not listed that should be included in a specific seal design's application. The purpose of this section is to relay the importance of including as much detailed information as possible for a particular seal design.*

- Provide information pertaining to the site location and site preparation. Information, which should be included, but not limited to, are:
  - Specify which ground conditions are to be avoided for seal design (*e.g., faults, cutters, floor heave, rib damage, etc.*)
  - Specify any ground remediation that might need to occur for site to be acceptable for seal design (*e.g., extra bolting, grouting, etc.*)
  - Specify the minimum strata strength requirements for the seal design and the means by which this strength would be determined.
  - Specify debris removal within 50 ft. inby and outby of seal location
  - Discuss loose material removal from roof and ribs at the seal site location (include distance inby/outby of the seal site location where removal would occur).
  - Discuss methods for removal of soft floor/fireclay to solid rock if these conditions are encountered.
  - Discuss acceptable set-back distances from the edge of pillar (10 feet minimum is generally acceptable). If less than a 10 feet set-back distance is required based upon site location limitations, then remediation and examination procedures must be listed.
  - Discuss the removal of any metal at the site location that might extend from one side of the completed seal to the other. Such items might include, but are not limited to, roof straps and wire roof mesh.
  - Specify the amount of water, if any, which would be allowed around the seal at the time of its construction.
  - Describe the actions to be taken to divert running water and to remove accumulated water from the seal construction site.

- Discuss what supplemental support requirements would be used (if any) around the seal location, such as cribs or cans.
  
- Provide information pertaining to the anchoring of the seal. Information, which should be included, but not limited to, are:
  - If material friction is used as an anchoring method, roughness requirements should be specified (*e.g., 1" in 4'*) and method to achieve those requirements should be discussed. Also, the amount of divergence allowed for the seal to still function as designed should be addressed.
  
  - If design relies on doweling as an anchoring method, the following information should be included, but is not limited to:
    - Bar diameter, grade and length (*e.g., No. 8, Grade 60, 60" long*)
    - Bar specification (*e.g., ASTM A615/A615M*)
    - Borehole diameter and depth (*e.g., 1-3/8" diameter, 30" deep*)
    - Pull testing and anchorage requirements (*e.g., 90% of bar yield*)
    - Acceptable grout (*e.g., specify commercial formulation suitable for bar/hole size*)
    - Rebar cleanliness (*e.g., Address removal of loose rust, scale, dirt, etc.*)
    - Hole/bar spacing (roof and floor) with tolerance (*e.g., 14" centers (+/- 2")*)
    - Roof to floor hole/bar offset (plumb/plane) tolerance (*e.g., (+/- 3")*)
    - Row spacing and tolerance for multiple rows (*e.g., 21" centers (+/- 1")*)
    - Coupling requirements and specifications (*e.g., to bars yield - ASTM A615/A615M*)
  
  - If seal design incorporates hitching, the following information should be included, but is not limited to:
    - Hitch locations (*e.g., floor and/or ribs*)
    - Hitch depth and width with tolerance (*e.g., 6" deep minimum, 30" wide, (+/- 2")*)
    - Hitch sharpness and cleanliness (*e.g., reasonably square and free of debris*)
    - Hitch-filling requirements (*e.g., space between seal and hitch wall filled with Type M mortar*)
  
  - If seal design incorporates angle irons, angle iron size, grade, and specifications should be included (*e.g., 6"x6"x3/4", Grade 50, ASTM A572*). Also, bolt specifications and spacings used with angle irons should also be included.

- If seal design incorporates internal reinforcement, the following information should be included, but not limited to:
  - Bar diameter, grade and length (e.g., No. 8, Grade 60, 72" long)
  - Bar specification (e.g., ASTM A615/A615M)
  - Stirrup diameter, grade and length (e.g., No. 4, Grade 60, 30" long)
  - Stirrup Specification (e.g., ASTM A615/A615M)
  - Wire mesh size and grade (e.g., 3" x 3" x 1/8", Grade 60)
  - Wire mesh specification (e.g., ASTM A615/A615M)
  - Reinforcement cleanliness: address removal of loose rust, scale, dirt, etc.
  - Bar/stirrup spacing with tolerance (e.g., 14" centers (+/- 2"))
  - Minimum bar spacing from ribs (roof and floor) with tolerance (e.g., 6" (+/- 1"))
  - Roof to floor hole/bar offset (plumb/plane) tolerance (e.g., (+/- 3"))
  - Row spacing and tolerance for multiple rows (e.g., 21" (+/- 1"))
  - Row straightness tolerances (e.g., (+/- 3"))
  - Wire mesh placement with tolerances: specify
  - Minimum reinforcement clearance/cover (e.g., 2.5" minimum)
  - Intersecting bar tying requirements (e.g., 16 gauge plastic coated tie wire)
  - Splice (lap) requirements (e.g., 36" minimum lap)
  - Coupling requirements and specifications (e.g., to bars yield – ASTM A615/A615M)
  - Coupling/splice alignment requirements (e.g., staggered and not aligned in plane)
  - Structural coating thickness tolerances (e.g., 3/16" (+/- 1/16"))
  
- If the seal design incorporates formwork, the following information should be included, but not limited to:
  - Use of existing seal as form wall
  - Rehabilitation/cleaning of existing seal: specify details
  - Form design specifications (e.g., ACI 347)
  - Form materials (e.g., 8" x 8" x 16" dry stack concrete block, sheet metal/gauge, etc.)
  - Form wall spacing (e.g., must maintain minimum seal thickness throughout)

- Minimum reinforcement cover (*e.g., 2.5" minimum*)
  - Alignment specifications (*e.g., straightness and plumb tolerances*)
  - Bracing requirements (*e.g., form shores, wedging, etc.*)
  - Form tightness requirements (*e.g., mortar tight*)
  - Vent/vent pipe placement: specify location and usage details
  - Dirt, dust debris removal: specify
  - Form tie material specifications (*e.g. structural fiberglass*)
- Describe method, equipment, and procedures to be used to batch, mix, transport, convey, and place seal materials.
  - Describe how you will ensure compliance with the standards affecting the health of miners installing seals and handling seal materials.
    - *e.g., the work area will be ventilated to maintain miners' dust exposures and/or chemical agent exposures at or below the applicable respirable dust standard and/or Threshold Limit Value®, respectively. Where necessary, NIOSH-approved respirators will be provided to all miners exposed to excessive dust and/or chemical agents. Miners' exposures to noise will be maintained within the permissible exposure limit through application of effective engineering and/or administrative controls, and personal hearing protectors will be provided to all miners exposed to noise exceeding the action level.*
  - Provide information on any requirements during curing of the seal, such as covering and monitoring.
  - Provide any other information that might be pertinent to Construction Specifications that might have not been discussed previously.

## **Quality Control**

- Address requirements for inspecting and accepting the prepared site before placement of the seal begins.
- Explain how personnel involved in the construction of the seal would be trained for their respective tasks.
- Provide requirements for the storage of the materials to be used to construct the seal; addressing moisture, heat, shelf life, designated location (both on the surface and underground), etc.



- If hazardous materials are used in the construction of the seal, provide procedures for transporting, handling, and storing such materials. This would include the responsible person knowing product location at all times.
- Specify guidelines for sampling of the materials used in the seal's construction during its installation and curing. Include the size, minimum number, frequency of sampling, and location of curing for the samples taken.
  - *e.g., Three, 6-inch diameter by 12-inch long cylindrical samples would be taken for every lift of installed material. The samples would be placed next to the constructed seal until the sample has cured for a designated time before testing.*
- Specify the type and number of tests to be conducted on the samples along with the pass/fail criterion.
  - *e.g., At least nine samples from each seal would be tested in compression. A minimum compressive strength of 4500 psi must be achieved for all samples tested in order to determine with a high degree of engineering certainty that the seal has cured to its design strength.*
- State that a certified laboratory along with qualified personnel would be conducting the sample testing. Specific lab information (along with documentation of certification) and personnel qualifications for those who would be performing the testing will be provided to the MSHA District and Technical Support before any tests are conducted.
  - *e.g., A certified laboratory along with qualified personnel, which would be deemed acceptable by the MSHA District and Technical Support prior to any tests performed, would be used for all quality control testing on the samples collected as specified previously.*
- Specify the party responsible for securing and transporting the quality control samples to the certified laboratory.
  - *e.g., After a designated time duration, the mine foreman will transport the samples from their underground curing location to the certified lab for quality control testing.*
- Provide information that seals are not considered to have reached their design strength until acceptable sample results have been received and reviewed by the MSHA District.
- Specify frequency of examining for convergence and actions to be taken if maximum convergence is exceeded.
  - *e.g. A convergence measurement will be taken and recorded during the regular examination of the seal. If this measurement exceeds the maximum allowable*

*convergence specified in the design, a P.E. must be contacted immediately to evaluate the effects of this convergence and certify the structural integrity of the seal and provide that certification to the MSHA District.*

- Specify the quality control measures taken for any material that cannot be sampled during its installation (e.g., concrete blocks, commercial mortar, etc.).
- Provide any other information that might be pertinent to Quality Control that might have not been discussed previously.

## **Design References**

- Provide a citation to all design manuals used in the design.

## **Other Information**

- Contact information should be provided with every seal design application. This contact information should include the name, address, telephone number, and e-mail address (if available) of the individual(s) who wish to be contacted if any questions, letters, or approvals need to be addressed, mailed, or granted.
- Provide any other information that might be pertinent to the submitted seal design that might have not been discussed previously.

## **Certification of Application**

- The application must be certified by a professional engineer that the design of the seal is in accordance with current prudent engineering practices and is applicable to the conditions in an underground coal mine.

## **Summary of Installation Procedures**

- Every seal design application will include complete, stand-alone, step-by-step installation procedures. These installation procedures should not contain proprietary information, since this information will be posted on the MSHA web site for ease of reference for all parties involved in the construction of the seal. These procedures should also not reference any information that is not included in the document (e.g., drawings that are in the seal design application (or any other location), but not in the installation procedures, should not be reference in the procedures.) The installation procedures should be as detailed as possible in order to avoid any confusion during

the construction and quality control process. The installation procedures will be submitted with the design application, but should be a separate packet from the design application.

## **Full Scale Testing Application**

- Please refer to the Final Rule under Sec. 75.335(b)(2) for the requirements associated with a Full Scale Testing application. Technical Support should be contacted before any full scale tests are conducted.

*NOTE: If an application is designed under this criteria, the only seal that could be constructed underground must be the exact seal design that was full-scale tested (no post-testing changes can be made to the design, unless another full-scale test is performed).*